exploration of the more important mussel-bearing streams with a view to ascertaining the extent and number of the mussel beds—the source of supply—was done by men trained in the work of pure science. The material thus secured was carefully worked over, classified and described—the work of the systematist—which was embodied in an admirable report. Then Lefevre and Curtis undertook to work out the anatomy and embryology of the mussels of economic importance and to ascertain the species of fish best fitted to act as carriers of the mussel larvæ or glochidia. All of this was purely scientific work, and the results were embodied in a paper entitled "Reproduction and Artificial Propagation of the Fresh-water Mussels," to my mind an excellent piece of work from a purely scientific standpoint.

With this as a basis, the work of propagation of mussels, the infection of fish best suited to act as hosts to the glochidia and the proposing of laws regarding the mussel industry as a whole could be followed intelligently and effectively. And this, of course, is practical or "applied" zoology.

Second. This laboratory, being in operation through the year, in which it differs from most others in this country, studies of the life histories and ecology of fluviatile species can best be pursued here, and should, in my opinion, be distinctly encouraged. Graduate students from our colleges and universities could be detailed to do this work and thus contribute to pure science and at the same time lay the foundations for work of a distinctly economic bearing.

Third. Material secured here, such as protozoans, mussels, annelids and small crustaceans, could be sent to the biological laboratories of neighboring states and serve a valuable end in supplying such laboratories with many forms desired for class work in botany and zoology.

The raw material from which the scientists of the future must, in the main, be secured is found in the college students now in classes; and anything that aids in the preparation of these students for their future life work will ultimately be of prime importance not only to pure science but also to applied science and the welfare of mankind.

The conference on the morning of the 8th was presided over by Professor Stephen A. Forbes, professor of entomology, University of Illinois, and chief of the Natural History Survey of Illinois. The leading address, entitled "The Biological Resources of our Inland Waters" was presented by Professor James G. Needham, of Cornell University, who has epitomized his remarks in the following terms:

Fish culture is a branch of animal husbandry. Animal husbandry makes progress about in proportion as it gives attention to the fundamental needs of animals, which are three: (1) Food, (2) Protection, and (3) Fit conditions for reproduction. Fish culture (as now practised) is not like other lines of animal husbandry because it gives adequate attention to only the last of these three. Further progress will lie in studying: (1) One species at a time, (2) One problem at a time, and (3) in one environment at a time. That is my creed for fish culture and for fish management and it applies to fish forage organisms and to fish enemies as well.

Several zoologists and business men participated in the general discussion relating to the subject of the conference.

The entire occasion was made agreeable and memorable through the generous cooperation of the National Association of Button Manufacturers, who gave luncheons at Fairport on the 7th and 8th and a banquet in Muscatine on the night of the 7th. The banquet in Muscatine was the occasion for a considerable number of extemporaneous talks by the various delegates present, and by persons representing the Station, the Bureau and the Department.

R. E. COKER

BRYOZOA AS FOOD FOR OTHER ANIMALS

BRYOZOA are common animals of the coastwise waters everywhere, but they have not been listed with any frequency in the food of other animals—in fact such references are exceedingly rare. It is of some interest, therefore, that I am able to record the fact that certain aquatic birds, at least occasionally, include them in their bill of fare.

Dr. E. W. Nelson, chief of the Bureau of Biological Survey, has recently sent me for determination a small collection of bryozoa taken from the stomachs of the king eider (*Somateria spectabilis*) and the Pacific eider (*Somateria v-nigra*). These ducks were taken

at the Pribilof Islands in the Bering Sea, and the presumption is that the bryozoa are from the same locality. The food records are as follows:

Crisia sp., from stomachs of the king eider and of two Pacific eiders, St. Paul I., Alaska, January 29 and 30, 1918.

Menipea pribilofi Robertson, from stomach of king eider, St. George I., Alaska, January 30, 1918.

Myriozoum subgracile d'Orbigny, from stomach of king eider, St. George I., Alaska, May 3, 1917.

Cellepora surcularis Packard, from stomachs of the Pacific eider, St. Paul I., Alaska, Mch. 21, 1915, and from the king eider, St. Paul I., Alaska, December 13, 1914 and January 29, 1918.

The amount of material in each case was small. The *Crisia* colonies were broken scraps and undeterminable as to species because of the lack of ovicells, though the general appearance was that of the common *C. denticulata* Lamarck. *Myriozoum subgracile* was represented by a branched portion 9 mm. long by 3 mm. thick, and *Cellepora surcularis* by irregular nodules 4 to 12 mm. in greatest diameter.

In all cases the animal matter seemed to have been digested out, leaving only the chitinous or calcareous matter of the ectocyst. Aside from the fact that they were considerably broken up, the specimens were in good condition for study, being as clean as though they had been treated with Javelle water. As Dr. Nelson suggests in a letter, it is probable that the ducks ate the *Crisia* and *Menipea* incidentally with other food, as these small branched species often grow attached to other organisms. The *Myriozoum* and *Cellepora* being nodular, may have been swallowed in lieu of pebbles.

In general the bryozoa must afford comparatively little nutriment, as the indigestible portion is so large, yet an animal pressed for food might be able to eke out an existence on them.

Certain fishes that habitually browse around ledges, rocks, wharves, etc., and which have teeth adapted for cutting off and crushing the shells of their prey, are known to include Bryozoa in their diet with some regularity. Thus, the cunner, *Tautogolabrus adspersus,* and the blackfish or tautog, *Tautoga onitis,* feed on bryozoa along with other hardshelled organisms. (See Sumner, Osburn and Cole, "Biological Survey of the Waters of Woods Hole and Vicinity," Bull. U. S. Bureau of Fisheries, Vol. XXXI., Part 2, 1911.) The kingfish, *Menticirrhus saxatilis,* also has been known to feed on bryozoa. The writer has observed *Bugula turrita* Desor and *Lepralia pallasiana* Moll among the stomach contents of the puffer or swellfish, *Spheroides maculatus.* On one occasion a couple of young puffers were placed over night in a finger bowl containing some colonies of the Endoproct, *Barentsia major* Hincks, and the next morning it was discovered that the puffers had returned my kindness in keeping them alive a few hours longer by eating the heads off of the most of the *Barentsia.* I have seen a considerable mass of *Bugula turrita* taken from the stomach of a smooth dogfish, *Mustelus canis,* and on several occasions have had referred to me for identification, nodules of *Smittina trispinosa nitida* Verrill and *Schizoporella unicornis* Johnston, from the stomachs of sharks. In one case the colony was half as large as my fist.

Bryozoa often grow in the greatest profusion, covering piles, rocks, shells, seaweed, etc., with growths so dense that they may entirely obscure the objects to which they are attached. At Woods Hole, Mass., during the summer of 1919, observations were made on *Bugula turrita,* growing on the rock wall of the Bureau of Fisheries dock, and on *Lepralia pallasiana,* encrusting the piles and timbers under the Coast Guard dock. Though in both cases the substratum was practically covered by the bryozoa and there were many other animals present, very few of the colonies showed injury of any sort. In nearly every case the colony form was perfect. It has been my experience in many years of dredging that

bryozoa colonies are usually complete, unless broken during dredging operations.

The bryozoan individual is always small, being rarely half as large as a pin head, but the colonial mass is often of sufficient size to render them desirable as food for numerous organisms, were it not for the fact that in nearly all cases they are well protected by heavy chitinous or calcareous walls. Only those animals provided with strong incisorial teeth or which can swallow the colony whole, can utilize them. Predaceous worms and other invertebrates probably are unable to feed on them to any extent, for in addition to its shell, the bryozoan is so highly irritable to tactile stimuli that it retracts into its shell with great rapidity at the slightest touch. Possibly some of the softer-bodied ctenostomes may serve as food for other invertebrates, but observations on this point are apparently lacking.

It should be added that the statoblasts of the freshwater bryozoa are often eaten by young fishes. During a survey of the fishes of Ohio, made during the past summer, statoblasts of *Pectinatella* and *Plumatella* were found among the stomach contents of the young of the large-mouth black bass, *Micropterus salmoides,* the crappie, *Pomoxis annularis,* the blue-gill sunfish, *Lepomis pallidus* and the gizzard shad, *Dorosoma cepedianum.* That these were picked up for food among other organisms of the same size there can be little doubt.

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COPPER IN ANIMALS AND PLANTS

In a recent number of *The Journal of Biological Chemistry* (Vol. 44, pp. 99–112, Oct., 1920) W. C. Rose and M. Bodansky report the finding of copper in various marine organisms, including Coelenterates, Mollusca, Crustacea, Elasmobranchs, and Teleostomi. As some of the writer's work bears on this subject, the following note is offered.

In some recent investigations on the respiration of insects the writer incinerated both the blood and entire specimens of over 30 species of insects, representing the chief orders. The ash was analyzed for copper, on the supposition that the copper present serves as the nucleus of a respiratory pigment, namely hemocyanin. In every case the ash reacted positively for copper with several reagents. The amount of copper present in insect blood is nearly proportionate to that present in crayfish blood, which was used as a control.

In addition to insects and crayfish, other Arthropods were incinerated, including several species of plankton Crustacea, spiders, daddy long-legs, and centipeds. In all cases copper was found. As representatives of other phyla *Volvox, Lumbricus, Ascaris,* snails and slugs, and the blood of garter snakes and human blood were incinerated. Of these all but the vertebrate blood reacted positively to tests for copper. As a matter of fact, the snake blood also appeared to show a minute trace of copper, but as the reaction developed with only one of the reagents used, and then only after several hours under alcohol vapor, this particular experiment is inconclusive.

The foregoing results indicate that the element copper has a wider distribution in living organisms than heretofore accepted. Its function has been definitely determined only for mollusks and Crustacea, where it forms the nucleus of a respiratory protein. Its presence in other Arthropods is explained on the same basis, that is, in all Arthropods copper forms the nucleus of hemocyanin. This is all the more probable, since, as already stated, the amounts present in insect blood, spiders and centipeds are proportionate to the amounts present in the crayfish blood used as a control.

In considering the source of the copper the writer analyzed the water of a creek from which most of his aquatic material was taken, and found distinct traces of the metal. The water as a source of copper is of importance to aquatic animals. It was shown, however, that terrestrial insects, including such highly specialized families as bees, ants and wasps, contained copper. These and other terrestrial insects, especially the herbivores, could derive